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EDGE TREATMENTS FOR COATED SUBSTRATES

Field of the Invention

The present invention provides a substrate bearing at least one functional coating. Also provided are insulating glass units, windows, and other glazing assemblies that include a substrate of this nature. More particularly, this invention provides a substrate having a coated surface of which a peripheral region is treated for contact with glazing compound. The invention also provides methods for treating peripheral regions of coated substrates. Durable glazing compounds are also provided, as are barrier layers for shielding glazing compound from functional coating.

Background of the Invention

Low-emissivity coatings are well known in the present art. These coatings are characterized by their ability to transmit high levels of visible light, while minimizing the transmittance of infrared radiation. Low-emissivity coatings help minimize the radiative heat transfer through windows and other glazing assemblies. Thus, during a cold winter, the heat loss from a warm room to the frigid outdoor environment is minimized. Likewise, during a warm summer, the heat radiated into a cool room from the hot outdoor environment is minimized.

Low-emissivity coatings typically comprise one or more infrared-reflective metallic layers. These metallic layers are commonly formed of silver, which is quite vulnerable to chemical attack. For example, silver is known to corrode when exposed to oxygen and moisture. When the silver in a low-emissivity coating corrodes, there is typically an attendant degradation of coating quality. For example, corrosion of the silver in a low-emissivity coating may reduce the infrared reflectivity of the coating, hence jeopardizing its intended function. This corrosion may also negatively impact the aesthetic appearance of the coated article. As a result, low-emissivity coatings are typically limited to use on the inner surfaces of multiple-pane insulating glass units (i.e., IG units), where these coatings are protected from the ambient environment.

Substrates bearing interior low-emissivity coatings are preferably edge deleted before being incorporated into IG units. This is perhaps best understood with reference to Figure 1, which illustrates the basic structure of a double-glazed IG unit. The IG unit comprises two panes 10, 10' held in a spaced-apart relationship by a spacer 101. The confronting, inner

surfaces 14, 14' of the panes 10, 10' define between them a sealable between-pane space 115. As is typical of low-emissivity IG units, the inner surface of one of the panes bears a low-emissivity coating 40.

Low-emissivity coatings are typically less than ideal for bonding with a spacer. As noted above, these coatings tend to lack chemical stability. This makes it difficult to durably bond a spacer to a surface bearing such a coating. For example, when the infrared-reflective material in a low-emissivity coating corrodes, it may be difficult to form or maintain a strong bond with the corroded surface. In Figure 1, for example, the bond between the spacer 101 and the inner surface 14 of the first pane 10 would be jeopardized by corrosion of the low-emissivity coating 40. Thus, to provide durable bonding of the spacer to the thus coated surface, it is desirable to remove the low-emissivity coating from the area of the inner pane surface to which the spacer will be bonded. This process is referred to as "edge deletion".

It is known to perform edge deletion of interior low-emissivity coatings. In this regard, reference is made to U.S. Patents 4,716,686 (Lisec) and 5,934,982 (Vianello et al.), the entire teachings of each of which are incorporated herein by reference.

Figure 2 illustrates an IG unit wherein edge deletion has been performed on an interior low-emissivity coating 40. The low-emissivity coating 40 has been removed from a peripheral region 140 of the inner surface 14 of the first pane 10. This allows the spacer to be bonded directly to the uncoated surface of the pane. It also keeps the edges 40E of the low-emissivity coating 40 from being exposed to the ambient environment. If the edges of a low-emissivity coating are exposed to the ambient environment (as in Figure 1), then corrosion may occur at the edges of the coating, potentially then spreading inward, such that the bond between the spacer and the pane is jeopardized. These corrosion problems can be largely avoided by performing edge deletion of the interior low-emissivity coatings used in IG units.

The IG units illustrated in Figures 1 and 2 each bear an exterior coating 20. Exterior coatings typically do not suffer from the corrosion problems discussed above. Thus, edge deletion has traditionally not been performed on exterior coatings. However, it would be advantageous to perform edge deletion of exterior coatings. For example, consider the manner in which IG units are typically installed.

Figure 3 exemplifies the installation of an IG unit into a very basic frame 50. The IG unit is retained in a glazing channel 60 of the frame 50. The glazing channel 60 is bounded by three mounting surfaces of the frame. Specifically, the glazing channel 60 is defined by two confronting mounting surfaces 55 and a base mounting surface 53. The edge regions of

the IG unit are encased by the confronting mounting surfaces 55. For illustration purposes, the edges 10E of the panes 10, 10' are shown as being spaced-apart from the base mounting surface 53. However, there would not typically be significant space between the installed IG unit and the base mounting surface 53 (although a gasket and/or glazing compound may be positioned therebetween).

Glazing compound (i.e., bedding material) is typically used to adhere the frame and the IG unit to one another. In Figure 3, the glazing compound 70 has been applied between the outer surfaces 12, 12' of both panes 10, 10' and the respective confronting mounting surfaces 55 of the frame 50. The outer surface 12 of the first pane 10 bears an exterior coating 20 that is not edge deleted. Thus, the glazing compound 70 adjacent the first pane 10 is bonded directly to the exterior coating 20.

Edge deletion of exterior coatings would facilitate reliable adherence of glazing compound. For example, glazing compound may bond less durably with certain glass coatings than with glass itself. Therefore, it would be beneficial to edge delete exterior coatings of this nature. It would even be beneficial to edge delete exterior coatings that are capable of being bonded durably and permanently to glazing compound. For example, even the most reliable coating method yields a certain percentage of defective coatings. Defective coatings may peel, or otherwise delaminate, from the substrates to which they are applied. As defective coatings would typically not provide good foundations for bonding with glazing compound, it would be advantageous to edge delete all types of exterior coatings.

It would be particularly advantageous to edge delete photocatalytic coatings. In recent years, a great deal of research has been performed on coatings that exhibit photoactivity. Photocatalytic coating technology is founded on the long known ability of certain materials to absorb radiation and photocatalytically degrade organic materials such as oil, plant matter, fats, and greases. The most powerful of these photocatalytic materials appears to be titanium oxide. However, other materials are reported to exhibit photoactivity as well.

Windows and other glazing assemblies would derive great benefit from photocatalytic coatings. For example, these coatings may have self-cleaning properties. When organic matter is deposited on a photocatalytic window coating, the coating may begin to chemically degrade these organic deposits, thereby having a cleaning effect on the coated surface. Moreover, to the extent any residue survives this photocatalysis, the residue may be more easily removed by washing or, for outdoor applications, by run-off rainwater.

One might not expect exterior photocatalytic coatings to require edge deletion. For example, consider once again the installation of an IG unit. As shown in Figure 3, the peripheral regions of the exterior coating 20 are typically concealed both by the glazing compound 70 and by the shoulders 57 of the frame 50. As a result, the peripheral regions of an exterior photocatalytic coating might not be expected to exhibit significant photoactivity. Photocatalytic coatings require both moisture and incident radiation to exhibit photoactivity. In principle, neither one of these commodity would be readily available at the concealed peripheral areas of an exterior coating. For example, glazing compound is intended to seal against water infiltration between the pane and the frame. Thus, moisture would not be expected to reach the coating areas sealed beneath the glazing compound. Moreover, these peripheral coating areas are typically sandwiched between the shoulders 57 of the frame 50. As a result, these coating areas would be largely shielded from incident radiation.

Notwithstanding this concealment of peripheral exterior coating, moisture and radiation both may reach the peripheral areas of an exterior photocatalytic coating. For example, glazing compound may have enough permeability to allow sufficient migration of moisture to these concealed coating areas to support photocatalysis. Further, while these peripheral coating areas may be shielded from direct radiation, multiple reflections within a pane or IG unit may deliver radiation to these coating areas in sufficient quantity to generate photoactivity. As a consequence, photoactivity may occur at the concealed peripheral areas of an exterior photocatalytic coating. The unfortunate result may be chemical degradation of nearby glazing compound.

Degradation of glazing compound may have undesirable consequences. For example, even the slightest deterioration of glazing compound may allow water to infiltrate between a monolithic pane or IG unit and the surrounding frame. This is perhaps best illustrated with reference to Figure 3. If water were to permeate the glazing compound 70 on either side of the IG unit, then the glazing channel 60 of the frame 50 may accumulate water. This could lead to corrosion of the underlying frame structure. In severe circumstances, the bottom of the IG unit may be left sitting in water, which could contain chemicals from glazing compound, sealant, paint, and a variety of other sources. Ultimately, this may cause the edge seal of the IG unit to fail, which would typically necessitate replacement of the entire IG unit.

Glazing compound deterioration may have other dire consequences as well. For example, glazing compound density and volume may decrease, potentially exacerbating the water infiltration problem discussed above. In extreme cases, this may eventually cause a

monolithic pane or IG unit to become loose in its frame. Moreover, depending upon the manner in which a given pane or IG unit is mounted, glazing compound deterioration may be a safety hazard. For example, in frameless glazing installations, panes may be fixed in position primarily by adhesion to glazing compound. In applications of this nature, deterioration of the glazing compound could conceivably cause a pane to fall from its mount at some time over the life of the product. This could be extremely dangerous, for example, in cases where the panes are carried against the exterior of a tall building or the like.

Summary of the Invention

In one embodiment, the invention provides a transparent pane having generally-opposed first and second major surfaces. Each of these major surfaces bears a functional coating and has a peripheral region that is substantially free of the functional coating.

In another embodiment, the invention provides a transparent pane having generally-opposed first and second major surfaces. At least one of these major surfaces bears an active coating and has a peripheral region that is substantially free of the active coating.

In still another embodiment, the invention provides a multiple-pane insulating glass unit comprising two spaced-apart panes and a spacer joining confronting, inner peripheral surfaces of the panes. The spacer and the confronting surfaces of the panes together define a between-pane space. At least one of the panes has an outer surface bearing a functional coating. This outer surface has a peripheral region that is substantially free of the functional coating.

In yet another embodiment, the invention provides a method of treating a coated substrate. The method comprises providing a transparent pane having generally-opposed first and second major surfaces. Each of these major surfaces bears a functional coating. Substantially all of the functional coating is removed from a peripheral region of the first major surface. Likewise, substantially all of the functional coating is removed from a peripheral region of the second major surface.

In a further embodiment, the invention provides a glazing assembly comprising a transparent pane having generally-opposed first and second major surfaces. At least one of these major surfaces bears an active coating. The glazing assembly includes frame in which at least one edge of the pane is received. The frame has a mounting surface against which the coated pane surface is retained. A bead of glazing compound is disposed between the mounting surface of the frame and a peripheral region of the coated pane surface. The

glazing compound is shielded from direct contact with the active coating by a barrier layer provided between the coated pane surface and the glazing compound.

In another embodiment, the invention provides a glazing assembly comprising a transparent pane having generally-opposed first and second major surfaces. At least one of these major surfaces bears an active coating. The glazing assembly includes a frame in which at least one edge of the pane is received. The frame has a mounting surface against which the coated pane surface is retained. A bead of glazing compound is disposed between the mounting surface of the frame and a peripheral region of the coated pane surface. The glazing compound is in direct contact with the active coating and comprises a material that is durable to the active coating.

In still another embodiment, the invention provides a frameless glazing assembly. The frameless glazing assembly comprises a transparent pane having generally-opposed first and second major surfaces. At least one of these major surfaces bears an active coating and has one or more surface regions that are each substantially free of the active coating. The assembly includes one or more mounts bounding a glazing opening in which the transparent pane is mounted. Each mount defines a mounting surface against which the coated pane surface is retained. A bead of glazing compound is disposed between each mount surface and a respective one of the coating-free surface regions.

Brief Description of the Drawings

Figure 1 is a schematic cross-sectional view of a known multiple-pane insulating glass unit;

Figure 2 is a cross-sectional view of another known multiple-pane insulating glass unit;

Figure 3 is a cross-sectional view of a frame in which the multiple-pane insulating glass unit of Figure 2 has been mounted;

Figure 4 is a cross-sectional view of a coated substrate in accordance with one embodiment of the present invention;

Figure 5 is a cross-sectional view of a frame in which the coated substrate of Figure 4 has been mounted in accordance with another embodiment of the invention;

Figure 6A is a front view of a major surface of a coated substrate in accordance with still another embodiment of the invention;

Figure 6B is a front view of a major surface of a coated substrate in accordance with yet another embodiment of the invention;

Figure 7 is a cross-sectional view of a multiple-pane insulating glass unit in accordance with a further embodiment of the invention;

Figure 8 is a cross-sectional view of a frame in which the multiple-pane insulating glass unit of Figure 7 has been mounted in accordance with another embodiment of the invention;

Figure 9 is a cross-sectional view of a frame in which a coated substrate has been mounted in accordance with a further embodiment of the invention;

Figure 10 is a cross-sectional view of a frame in which a multiple-pane insulating glass unit has been mounted in accordance with another embodiment of the invention;

Figure 11 is a cross-sectional view of a frame in which a coated substrate has been mounted in accordance with still another embodiment of the invention;

Figure 12 is a cross-sectional view of a frame in which a multiple-pane insulating glass unit has been mounted in accordance with yet another embodiment of the invention;

Figure 13 is a cross-sectional view of a coated substrate in accordance with a further embodiment of the invention; and

Figure 14 is a cross-sectional view of a frameless glazing assembly in accordance with another embodiment of the invention.

Detailed Description of Preferred Embodiments

The present invention provides edge treatments for coated substrates. These edge treatments afford particular advantage in mounting coated substrates into window frames and the like. In the present disclosure, the term "interior coating" is used to refer to a coating that is exposed to the between-pane space 115 of an IG unit. On the other hand, the term "exterior coating" is used herein to refer to a coating that is exposed to an environment other than the between-pane space 115 of an IG unit. Typically, exterior coatings will be exposed to unprotected, ambient environments. However, by identifying a given coating as an exterior coating, it is not necessarily represented that the coating is exposed to an outdoor environment, for example, unless such requirement is specifically stated.

The invention can be used favorably with a wide variety of substrates. In particular, the substrate class comprising generally flat, sheet-like substrates is favored. A substrate of this nature typically has two generally-opposed major surfaces. In most cases, the substrate

will be a sheet of transparent material (i.e., a transparent pane). For example, the substrate may be a pane of glass. One type of glass that is commonly used in manufacturing glass articles (e.g., insulating glass units) is soda-lime glass. Soda-lime glass will be a preferred substrate in many cases. Of course, other types of glass can be used as well, including those generally referred to as alkali-lime-silicon dioxide glass, phosphate glass, and fused silicon dioxide. It is noted that the substrate is not required to be transparent. For example, opaque substrates may be useful in some cases. However, it is anticipated that for most applications, the substrate will comprise a transparent or translucent material, such as glass or clear plastic.

The invention provides numerous embodiments wherein a coated substrate is provided with at least one exterior coating. Unless expressly stated, the exterior coating in each embodiment can be of any desired type. For example, it is contemplated that the invention will bestow particular benefit upon substrates bearing an active exterior coating, such as an exterior photocatalytic coating. It is to be understood that the term "active coating" is used herein to refer to a coating, whether currently known or subsequently developed, that has self-cleaning properties. As noted above, self-cleaning coatings may be degenerative to glazing compound and the like. Therefore, the edge treatments of this invention are particularly advantageous for substrates bearing active (or "self-cleaning") coatings.

A variety of photocatalytic coatings are known. For example, useful photocatalytic coatings are described in U.S. Patents 5,874,701 (Watanabe et al), 5,853,866 (Watanabe et al), 5,961,843 (Hayakawa et al.), 6,139,803 (Watanabe et al), 6,191,062 (Hayakawa et al.), 5,939,194 (Hashimoto et al.), 6,013,372 (Hayakawa et al.), 6,090,489 (Hayakawa et al.), 6,210,779 (Watanabe et al), 6,165,256 (Hayakawa et al.), and 5,616,532 (Heller et al.), the entire teachings of each of which are incorporated herein by reference.

The most powerful photocatalytic coatings appear to be based on titanium oxide (e.g., titanium dioxide or substoichiometric titanium oxide, TiO_x, such as where x is between 1 and 2). Useful titanium oxide coatings are disclosed in the book *TiO_2 Photocatalysis Fundamentals and Applications* (First Edition, May 1999, BKC, Inc.), the entire teachings of which are incorporated herein by reference. Particularly useful photocatalytic coatings can be sputter deposited in accordance with the teachings of U.S. patent application 60/262,878, the entire teachings of which are incorporated herein by reference. In one particularly useful embodiment, a transparent pane has an edge-deleted photocatalytic coating on one of its major surfaces and an edge-deleted low-emissivity coating on its other major surface.

As noted above, there is a great deal of ongoing research in the area of self-cleaning coatings. As a consequence, new photocatalysis-based coatings are being developed on an ongoing basis. Moreover, the development of self-cleaning coatings based on mechanisms other than photocatalysis is anticipated. In this regard, the present invention would be of great value to any self-cleaning coating that is degenerative to glazing compound or the like, regardless of the particular mechanism that provides the self-cleaning effect. Thus, it is anticipated that the present invention will be used advantageously in connection with self-cleaning coatings that have yet to be developed, whether or not these coatings are photocatalytic.

The present edge treatments can also be used quite advantageously in connection with substrates bearing an exterior hydrophilic coating. Hydrophilic coatings have an affinity for water. As a result, water on a hydrophilic coating will tend to spread into a uniform sheet, rather than beading up. Hydrophilic coatings are particularly advantageously for applications where there will not be a constant flow of high velocity air moving over the coated surface (e.g., architectural glass applications). Particularly useful hydrophilic coatings are disclosed in U.S. patent applications 09/868,542, 09/868,543, 09/572,766, and 09/979,325, the entire teachings of each of which are incorporated herein by reference. In one embodiment, a transparent pane has an edge-deleted hydrophilic coating on one of its major surfaces and an edge-deleted low-emissivity coating on its other major surface.

The present edge treatments can also be used advantageously in connection with an exterior hydrophobic coating. Hydrophobic coatings are characterized by their tendency to repel water. Thus, water on a hydrophobic coating tends to bead up, forming discrete droplets, rather than spreading over the coated surface. Hydrophobic coatings are advantageous for applications where there will be a constant flow of high velocity air moving over the coated surface (e.g., automobile windshields). In such applications, the water-beading effect facilitates water removal from the coated surface by allowing droplets to be blown readily from the coated surface. A variety of hydrophobic coatings are known. For example, useful hydrophobic coatings are disclosed in U.S. Patent 5,424,130 (Nakanishi et al.), the entire teachings of which are incorporated herein by reference.

As noted above, the exterior coating or coatings can be of any desired type in most embodiments of the invention. For example, it may be desirable to employ an exterior coating that is antireflective, highly (e.g., selectively) reflective, etc. Further, skilled artisans will wish to select other types of coatings to achieve other desired substrate properties. Thus,

while certain types of coatings are discussed herein for illustrative purposes, the invention is not limited to use with any particular coatings.

In many cases, the exterior coating will be exposed to an unprotected, ambient environment. As a consequence, the exterior coating is preferably formed of material that does not readily corrode when exposed to air and moisture. For example, it may be advantageous if the exterior coating is a non-silver-based coating (i.e., one that does not contain a major silver component). In fact, it may be preferable to employ exterior coatings that are substantially, or even entirely, free of silver and other materials that are vulnerable (e.g., that corrode when exposed) to oxygen, moisture, or other components of ambient air. However, certain silver-containing coatings may actually be advantageous for use as an exterior coating (e.g., those having appropriate protection of the silver). As such, it may be preferable to incorporate a silver-based exterior coating into certain embodiments hereof.

It is presently contemplated that the exterior coating will be a thin film coating (e.g., comprising one or more layers of metal, metal alloy, and/or dielectric material). While there are no thickness limitations on coatings of the invention, it is contemplated that each coating will have an overall thickness of well below 10,000 angstroms (e.g., less than about 2000 or about 3000 angstroms). For example, in embodiments involving a photocatalytic coating, the total thickness of the coating may be on the order of 1,000 angstroms or less, and more preferably on the order of 500 angstroms or less.

Figure 4 illustrates one embodiment of the invention that involves a coated substrate 10. The substrate 10 has generally opposed first 12 and second 12' major surfaces. In this particular embodiment, each major surface bears a functional coating. The functional coating on the first major surface 12 is designated by the reference numeral 20, while the functional coating on the second major surface 12' is designated by the reference numeral 20'. The nature of these coatings can be varied depending on the properties intended for the coated substrate 10. For example, one or both coatings in this embodiment can be an exterior coating. Thus, any of the coating types discussed above would be suitable. In one embodiment, one of the coatings is a photocatalytic coating and the other is a low-emissivity coating. In another embodiment, one of the coatings is a hydrophilic coating and the other is a low-emissivity coating. A variety of other coatings and coating combinations could also be used and would fall within the scope of the invention.

Edge deletion has been performed on both major surfaces of the illustrated substrate 10. That is, each major surface has a peripheral region from which the functional coating has

been substantially removed. For example, the first major surface 12 has a peripheral region 120 from which the functional coating 20 has been substantially removed. Likewise, the second major surface 12' has a peripheral region 120' from which the functional coating 20' has been substantially removed. As discussed below, each coating-free peripheral region can extend completely about the periphery of the coated surface, or it may extend only about a partial periphery of the coated surface, as desired. The coating-free peripheral regions 120, 120' facilitate substrate installation, as will be appreciated given the present teaching.

A substrate like that shown in Figure 4 can be used in a variety of applications. For example, a substrate 10 of this nature can be used as one of the panes in a multiple-pane IG unit (as illustrated in, and discussed with reference to, Figure 7). Alternatively, a substrate of this nature can be used in a monolithic glazing assembly (as illustrated in, and described with reference to, Figure 5). Skilled artisans will also appreciate other applications (e.g., frameless glazing applications) that would derive benefit from a coated substrate of this nature.

Figure 5 illustrates an embodiment wherein a monolithic substrate 10 has been installed in a frame 50. The term "frame" is used herein to refer to any structure to which a monolithic substrate or IG unit can be mounted. The term would include frames, sashes, and any other structure that serves a similar purpose. In most cases, the frame will be configured to receive at least one edge (and typically all edges) of a monolithic pane or IG unit. While the illustrated frame has a very simple construction, any desired frame design can be used. Moreover, the frame 50 can be part of a window, door, skylight, or any other type of glazing assembly.

In Figure 5, both of the coatings 20, 20' are depicted as being exterior coatings (i.e., neither is exposed to the between-pane space of an IG unit). The invention provides a number of different embodiments of this nature. For example, in one preferred embodiment, both coatings 20, 20' are photocatalytic. In another preferred embodiment, both coatings 20, 20' are hydrophilic. In still another preferred embodiment, the first coating 20 is photocatalytic and the second coating 20' is hydrophilic. Many other types of coatings and coating combinations can be used and would fall within the scope of the invention.

The edge 10E of the substrate 10 in Figure 5 is retained in a glazing channel 60 of the frame 50. Thus, the width of the glazing channel 60 in this embodiment is preferably substantially equal to, or slightly greater than, the width of the pane 10. The coating-free peripheral regions 120, 120' of the substrate 10 are encased by confronting mounting surfaces

55 of the frame 50. In the illustrated embodiment, glazing compound 70 has been applied between both coating-free peripheral regions 120, 120' and respective confronting mounting surfaces 55 of the frame 50. For example, the glazing compound 70 adjacent the first major surface 12 is bonded directly to the first coating-free peripheral region 120. Likewise, the glazing compound 70 adjacent the second major surface 12' is bonded directly to the second coating-free peripheral region 120'. By bonding the glazing compound directly to these uncoated surfaces, reliable bonds can be formed between the glazing compound and the pane 10.

The frame construction and manner of applying glazing compound can be varied. For example, a single bead of glazing compound may be applied between only one of the confronting frame surfaces 55 and the adjacent coating-free peripheral region. In such cases, it will be particularly advantageous to edge delete the peripheral region of the surface that will be bonded to the glazing compound (or to utilize one of the other edge treatments of the invention on this surface), as the adhesion of this bead of glazing material may be all that keeps the substrate 10 from being loose in the glazing channel 60. This may be even more important for frameless glazing assemblies, like that illustrated in Figure 14, as the glazing compound's adherence to the pane 10 would obviously be important for pane retention.

In Figure 5, the edge 10E of the pane 10 is depicted as being spaced-apart from the base mounting surface 53. The monolithic panes and IG units of Figures 7-12 are also illustrated in this manner. However, this is done for illustration purposes, and there typically would not be significant space between an installed monolithic pane or IG unit and the base mounting surfaces of a frame. For example, monolithic panes and IG units are commonly installed such that the edges 10E of each pane abut the base mounting surfaces 53. In some cases, though, a gasket and/or glazing compound can be provided between the edges 10E of each pane and the base mounting surfaces 53.

The coating-free peripheral region extends a certain distance inwardly from the edge 10E of the substrate 10. This distance, which may be predetermined, is referred to herein as the "edge-deletion width". Specifically, the edge-deletion width is defined as the distance from an edge 10E of a substrate, along a coated major surface of the substrate, to an adjacent edge 20E of the remaining coating 20. Generally speaking, an edge-deletion width of less than about one inch, and perhaps optimally about ½ inch, would be suitable for most conventional applications. Of course, different edge-deletion widths can be selected for different applications. In most cases, it will be preferable to employ an edge-deletion width

that is uniform along all sides of the coated surface, at least along the length of a given side of the coated surface.

The edge-deletion width is preferably selected such that the coating-free region will be hidden from view once the substrate has been mounted. This is expected to be advantageous in all embodiments of the invention, particularly in cases where the deleted coating is optically significant, as the boundaries of the coating-free regions may otherwise be visible. Thus, it is preferable for each coating-free peripheral region to be outside the vision area of the glazing assembly. For example, each coating-free peripheral region can be hidden from view by the shoulders 57 of a frame 50. In more detail, the outer edge 20E, 20'E, 40E, 420E of the edge deleted coating 20, 20', 40, 420 is preferably positioned further outward (i.e., closer to the mounting surface 53 of the frame 50) than the inner edge 57E of the shoulders 57 of the frame 50 after installation. In cases where the edge of each pane is mounted directly against the base mounting surface 53 of a frame 50, this can be accomplished by selecting an edge-deletion width that is less than the depth of the glazing channel 60. In cases where a gasket and/or glazing material is positioned between the edge of each pane and the base mounting surface 53 of the frame 50, this can be accomplished by selecting an edge-deletion width that is less than the distance the confronting frame surfaces 55 will extend over respective peripheral pane surfaces. In other words, it is generally preferred to select edge-deletion widths that will leave the coating-free peripheral regions hidden from view following installation.

Figure 5 illustrates an embodiment wherein the glazing compound 70 is bonded only to the coating-free peripheral regions 120, 120' of the substrate 10 (i.e., with no overlap of glazing compound and coating). While this is preferred to assure reliable bonding, it is not a strict requirement. For example, some of the glazing compound may somewhat overlap the remaining exterior coating. However, it is preferable in these cases if a major portion of the glazing compound is bonded directly to the coating-free peripheral region. In most cases, it will be desirable to edge delete enough exterior coating to assure that a conventional bead of glazing compound can be bonded to each coating-free peripheral region without any contact between the glazing compound and the remaining coating.

It is particularly advantageous to bond the glazing compound only to the coating-free peripheral region when the edge-deleted coating is an active coating. Active coating is preferably not placed in direct contact with conventional glazing compound, as the coating may otherwise chemically degrade the glazing compound. While this chemical degradation

may not completely destroy the bond between the glazing compound and the pane, it may still adversely affect the seal between the glazing compound and the pane.

In addition to varying the edge-deletion width, the configuration of each coating-free peripheral region can be varied as desired. For example, Figure 6A illustrates an embodiment wherein edge deletion has been performed about the entire periphery of the coated surface. In most cases, it will be preferable to edge delete in this manner. For example, when a substrate is mounted in a conventional window frame, the glazing compound is typically applied about the entire periphery of the substrate. In other cases, multiple substrates may be installed in an edge-to-edge fashion, such that the glazing compound is only applied about two peripheral areas of the pane (e.g., top and the bottom peripheral areas). In such cases, it would not be necessary to edge delete the entire periphery of the coated surface. For example, Figure 6B illustrates an embodiment wherein edge deletion has only been performed on the top and bottom peripheral areas of the coated surface.

As noted above, a substrate 10 like that shown in Figure 4 can be incorporated into a multiple-pane IG unit. One embodiment of this nature is illustrated in Figure 7. In this embodiment, at least one of the panes 10, 10' bears a functional coating on its outer surface (i.e., the surface oriented away from the between-pane space 115). In other words, the IG unit of this embodiment carries at least one exterior coating. In Figure 7, the outer surface 12 of the first pane 10 bears a functional coating 20, while the outer surface 12' of the second pane 10' is uncoated. Alternatively, the outer surface 12' of the second pane 10' can be provided with a functional coating (not shown), and the outer surface 12 of the first pane 10 can be left uncoated. As still another alternative, the outer surfaces of both panes can be provided with functional coatings, if so desired.

The nature of the exterior coating or coatings can be varied depending on the properties intended for the IG unit. For example, any of the exterior coating types discussed above would be suitable for use in this embodiment. In one particularly preferred embodiment, the exterior coating 20 illustrated in Figure 7 is an active coating (e.g., a photocatalytic coating). In another particularly preferred embodiment, this coating 20 is a hydrophilic coating. In other embodiments, this coating may be hydrophobic, highly (e.g., selectively) reflective, or antireflective. In most case, it is desirable to form each exterior coating of material that does not readily corrode when exposed to air and moisture.

As noted above, if both panes of the IG unit bear exterior coatings, then the nature of these two coatings can be the same or different, depending on the properties intended for the

IG unit. For example, an IG unit like that depicted in Figure 7 can be provided with active exterior coatings on both panes 10, 10' (not shown). Alternatively, an IG unit of this nature can be provided with hydrophilic exterior coatings on both panes. As still another alternative, an active coating can be provided on one pane, while another functional coating (e.g., a hydrophilic or hydrophobic coating) is provided on the outer surface of the other pane. Many other combinations are possible and would fall within the scope of the invention.

In the present embodiment, the IG unit has at least one exterior coating that is edge deleted. In Figure 7, only the first pane 10 of the IG unit bears an exterior functional coating 20. Thus, the outer surface 12 of this pane 10 has been edge deleted. That is, it has a peripheral region 120 that is substantially free of the functional coating 20. As discussed below, this facilitates reliable installation of the IG unit. In cases where both panes of the IG unit are provided with exterior coatings, it will typically be advantageous to edge delete the coatings from the outer surfaces of both panes.

In embodiments of the invention that involve a multiple-pane IG unit, one or both panes can optionally be provided with an interior low-emissivity coating. Low-emissivity coatings are quite well known in the present art. Particularly useful low-emissivity coatings are described in U.S. patent applications 09/728,435, 09/898,545, and 09/189,284. Moreover, a pyrolytically-applied low-emissivity coating can be incorporated into any embodiment of the invention, in the nature of an interior and/or exterior coating. Coatings of this nature are described in U.S. Patent 5,698,262 (Soubeyrand et al.), the entire teachings of which are incorporated herein by reference.

In Figure 7, the first pane 10 of the IG unit bears an interior low-emissivity coating 40. Alternatively, the second pane 10' can be provided with an interior low-emissivity coating (not shown). As another alternative, both panes can be provided with interior low-emissivity coatings, if so desired. Each interior low-emissivity coating 40 is preferably edge deleted to facilitate bonding with the spacer 101. This is illustrated in Figure 7, wherein the inner surface of the first pane 12 has a peripheral region 140 that is substantially free of the low-emissivity coating 40.

Figure 8 illustrates an embodiment wherein a multiple-pane IG unit has been mounted in frame. The resulting glazing assembly generally includes the IG unit, the frame, and glazing compound 70. The IG unit of Figure 8 has the same basic structure as that shown in Figure 7. Similarly, the frame 50 illustrated in Figure 8 has the same basic structure as that of Figure 5. For example, the frame 50 is configured to receive at least one edge of the IG unit.

Thus, the edge regions of the IG unit are encased by confronting mounting surfaces 55 of the frame 50. Unlike the frame in Figure 5, however, the frame in Figure 8 is adapted to accommodate a multiple-pane IG unit, rather than a monolithic pane. Thus, the width of the glazing channel 60 in this embodiment is preferably substantially equal to, or slightly greater than, the width of the IG unit.

In the present embodiment, at least one of the panes carries a functional coating on its outer surface. In Figure 8, the first pane 10 bears a functional exterior coating 20. Alternatively, the second pane 10' can be provided with a functional exterior coating (not shown). As still another alternative, the outer surfaces of both panes can be provided with functional coatings. As with the IG unit of Figure 7, the nature of each exterior coating in the embodiment of Figure 8 can be varied depending on the properties intended for the mounted IG unit.

In this embodiment, the mounted IG unit bears at least one edge-deleted exterior coating. In Figure 8, the first pane 10 of the IG unit bears the edge-deleted exterior coating 20. Thus, the outer surface 12 of this pane 10 has a peripheral region 120 that is substantially free of the functional coating 20. A bead of glazing compound 70 is disposed between this coating-free peripheral region 120 and the adjacent mounting surface 55 of the frame 50. This coating-free peripheral region 120 provides an uncoated surface to which the glazing compound 70 is directly bonded. This allows a strong, durable bond to be formed between the glazing compound and the pane. In cases where both panes of a mounted IG unit bear exterior coatings (not shown), it will be preferable to edge delete the outer surfaces 12, 12' of both panes 10, 10', at least if glazing compound 70 will be applied against the outer surfaces of both panes.

One or both panes of the mounted IG unit can be provided with an optional interior low-emissivity coating 40. For example, the first pane 10 of the IG unit bears an interior low-emissivity coating 40. Alternatively, the second pane 10' can be provided with an interior low-emissivity coating (not shown). In fact, both panes can be provided with interior low-emissivity coatings, if so desired. Each interior low-emissivity coating 40 is preferably edge deleted to facilitate bonding with the spacer 101. Thus, the inner surface 14 of the first pane 12 illustrated in Figure 8 has a peripheral region 140 that is substantially free of the low-emissivity coating 40. It may be preferable to edge delete such interior low-emissivity coatings such that they will be outside the vision area of the glazing assembly following installation.

In embodiments that involve a monolithic pane or IG unit mounted in a frame with glazing compound, the glazing compound desirably prevents water from infiltrating between the frame and the pane or IG unit. Thus, it is desirable to maintain the integrity of the bond between the glazing compound and each pane. For example, in the embodiment of Figure 8, if the bond between the glazing compound 70 and the first pane 10 were to deteriorate, water could gather in the glazing channel 60. In severe circumstances, this could leave the bottom of the IG unit sitting in water, which could eventually cause failure of the IG unit's end seal. Thus, it is desirable to assure that any exterior coating on a mounted pane or IG unit will not adversely affect the bonding of glazing compound to the IG unit. The edge treatments of the present invention are quite advantageous in this regard.

Figure 13 depicts another preferred embodiment of the invention. In this embodiment, there is provided a substrate (e.g., a transparent pane) having generally-opposed first and second major surfaces. At least one of the major surfaces 12, 12' bears an active coating 420 (e.g., a photocatalytic coating). This coating 420 is preferably, though not necessarily, an exterior coating. The active coating 420 is edge deleted, such that the surface 12 bearing this coating 420 has a peripheral region 120 that is substantially free of the active coating. The width (i.e., the edge-deletion width) of the coating-free peripheral region 120 is preferably substantially uniform (and is optionally predetermined) over the entire periphery of the pane, or at least along the length of a given side of the coated surface, as described above. In the present embodiment, the other major surface 12' of the substrate 10 may be uncoated, or it may bear its own coating. For example, both surfaces 12, 12' of the substrate 10 may bear active coatings. Further embodiments of this nature are discussed above with reference to Figures 4 and 5.

Figure 14 depicts still another preferred embodiment of the invention. This embodiment involves a frameless glazing assembly. In Figure 14, the illustrated glazing assembly includes an IG, although it will be appreciated that the frameless mounting structure may alternatively carry a monolithic pane. The illustrated mounting structure comprises one or more mounts 150, which are depicted in Figure 14 as bodies having a generally "L"-shaped cross section. The mount or mounts 150 bound a glazing opening in which the IG is mounted. The present embodiment is not limited to any particular type of frameless mounting structure. To the contrary, other types of frameless mounting structures (e.g., having differently configured mounting surfaces, to which the pane or IG is affixed) can be used and would fall within the scope of the invention.

With continued reference to Figure 14, the illustrated frameless mounting structure has mounting surfaces 155 to which the IG unit is adhesively affixed. A bead of glazing compound, sealant, or adhesive is applied between each mounting surface 155 and a peripheral region of the first pane 10. The outer surface 12 of this pane 10 bears an active coating 42 (e.g., a photocatalytic coating). The active coating 420 in this embodiment is edge deleted. That is, the outer surface 12 of the first pane 10 has a peripheral region 120 that is substantially free of the active coating 420. This allows the glazing compound 70 to be bonded directly to the coating-free peripheral region 120 of the pane 10. As noted above, this facilitates reliable bonding of the glazing compound 70 to the pane 10. In frameless glazing embodiments, it can be appreciated that the integrity of the bond between the glazing compound 70 and the pane 10 is particularly important. For example, failure of this bond could conceivably cause the mounted pane or IG unit to fall from its mount, potentially creating a safety hazard, especially in cases where the pane or IG unit is mounted to the exterior of a tall building or the like.

The present invention also provides methods for treating a coated substrate. These method involve providing a substrate (e.g., a transparent pane) having generally opposed first and second major surfaces each bearing a functional coating. The functional coating is substantially removed from a peripheral region of the first major surface. Likewise, the functional coating is substantially removed from a peripheral region of the second major surface. This edge deletion can be performed using any desired coating-removal technique.

In a favored method of the invention, these coatings are removed by performing grinding operations on the substrate. For example, a conventional grinding wheel can be moved manually about the periphery of each coated surface. Alternatively, a grinding wheel can be mounted in a fixed position while the substrate is translated past, and acted upon by, the grinding wheel. Useful grinding wheels and grinding methods are described in U.S. Patents 4,716,686 (Lisec) and 5,934,982 (Vianello et al.), the entire teachings of each of which are incorporated herein by reference. Rather than grinding away these coatings, edge deletion can be performed using torches fueled by combustible gas, through electrical discharge, or using any other desired coating-removal process.

In a particularly favored method of the invention, the functional coatings are removed from both coated surfaces substantially simultaneously. For example, edge deletion can be performed on both major surfaces of a substrate in a single pass through a grinding apparatus. In one method, two grinding wheels are used to simultaneously edge delete the coatings from

both major surfaces of the substrate. The method involves first and second grinding wheels positioned on opposite sides (e.g., above and below) of a path along which the substrate will travel (i.e., on opposite sides of the path of substrate travel). The grinding wheels are preferably separated by a distance that is substantially equal to the thickness of the uncoated substrate. The substrate is translated between the grinding wheels such that coatings are removed simultaneously from both major surfaces of the substrate. Particularly useful edge-deletion equipment and methods are described in U.S. patent application 60/267,507, the entire teachings of which are incorporated herein.

Figure 9 illustrates a further embodiment of the invention involving a monolithic glazing assembly. In this embodiment, the invention provides a glazing assembly that generally includes a monolithic substrate (e.g., a transparent pane), a frame, and glazing compound. The substrate 10 has generally opposed first 12 and second 14 major surfaces. At least one of the major surfaces bears an active coating (e.g., a photocatalytic coating). In Figure 9, the substrate 10 bears an active coating 420 on its first major surface 12, while its second major surface 12' is uncoated. Alternatively, the second major surface 12' can be provided with an active coating (not shown), and the first major surface 12 can be left uncoated. As still another alternative, both major surfaces of the substrate can be provided with coatings. For example, active coatings can be provided on both major surfaces. Alternatively, an active coating can be provided on one major surface, while another type of coating (e.g., hydrophilic, hydrophobic, etc.) is provided on the other major surface. In such cases, the nature of the coating on the other major surface (i.e., the non-active coating) can be varied depending on the properties intended for the coated substrate.

In the present embodiment, the surface 12 bearing the active coating 420 is retained against a mounting surface 55 of the frame 50. Thus, in Figure 9, the first major surface 12 of the substrate 10 is retained against the adjacent mounting surface 55 of the frame 50. The illustrated frame 50 has the construction described above (e.g., having a generally "C"-shaped cross section), wherein at least one edge (e.g., all edges) of the substrate is received in the frame. However, any desired frame construction can be used in this embodiment.

In Figure 9, glazing compound is applied between the frame and both major surfaces of the pane, although this is not a requirement. For example, the glazing compound 70 can simply be disposed between a peripheral region of the surface 12 bearing the active coating 420 and the adjacent mounting surface 55 of the frame 50. In the present embodiment, a barrier layer 90 is provided between the active coating 420 and the glazing compound 70.

This barrier layer 90 shields the glazing compound from direct contact with the active coating 420. The barrier layer 90 is provided to prevent deterioration of the glazing compound by keeping the glazing compound and the active coating out of contact with one another.

The barrier layer 90 can be applied between the glazing compound 70 and the active coating 20 in any desired manner. It may be preferable to secure the barrier layer 90 to the substrate 10 prior to installation. This would allow the substrate to be positioned on the frame without having to simultaneously manipulate the substrate 10 and the barrier layer 90 relative to one another. For example, the barrier layer 90 may be applied (e.g., painted, sprayed, etc.) onto the substrate in the form of a liquid that can subsequently be solidified (e.g., by applying heat). In one preferred embodiment, the barrier layer 90 is printed, stamped, taped, or extruded onto the peripheral region of the coated surface 12. For example, the barrier layer 90 may be applied in the form of a printable foil or film. Yet another alternative (not shown) involves forming a sealing strip comprising a barrier layer portion (such as may be provided in the form of a backing for the sealing strip) on one side and a glazing compound portion on the other side. A sealing strip of this nature could be adhered to the mounting surface 55 of the frame 50 with its barrier layer portion oriented toward the intended position of the substrate 10.

The barrier layer 90 is advantageously formed of material that is durable to the active coating 20. That is, the barrier layer 90 is preferably formed of material that is resistant to the self-cleaning mechanism of the active coating, whatever that mechanism may be. This is preferable so the barrier layer 90 itself will not be chemically degraded by the active coating 20. For example, in cases where the active coating 20 is photocatalytic, the barrier layer 90 is desirably formed of material (e.g., an inorganic material) that is resistant to attack by the free radicals that can be generated at the surface of a photocatalyst.

The barrier layer 90 is preferably positioned entirely outside the vision area of the glazing assembly. Thus, the barrier layer 90 is desirably sized, shaped, and positioned such that its inner edge 90I is below (or outside) the inner edge 57I of the frame. Since the barrier layer 90 will commonly be out of sight, it is possible to employ metals and other durable materials that are thick enough and/or opaque enough to be optically significant. Thus, in one embodiment, the barrier layer 90 comprises an optically transparent film of metal, metal alloy, or dielectric material.

The barrier layer can be formed of a variety of durable materials. For example, U.S. patent 5,547,825 ("the '825 patent"), the entire teachings of which are incorporated herein by

reference, describes a number of materials as being durable to photocatalysis. It is anticipated that these materials would be useful in forming the present barrier layer 90. These materials include silicon compounds, such as water glass, colloidal silica, polyorganosiloxanes, and the like. Also included are phosphates, such as zinc phosphate and aluminum phosphate. The '825 patent also describes certain organic materials, including fluorinated polymers and silicone-based polymers, as being durable to photocatalysis. U.S. Patents 5,616,532, 5,849,200, and 5,854,169, the entire teachings of each of which are incorporated herein by reference, also disclose materials that are expected to be useful in forming the present barrier layer 90.

Fluorinated polymers may be advantageous when it is important to maximize the adhesive strength of the barrier layer 90. It is anticipated that a variety of fluorinated polymers would be advantageous in this regard, including: crystalline fluorinated resins such as polyvinyl fluorides, polyvinylidene fluorides, polyethylene trifluorochlorides, polyethylene tetrafluorides, tetrafluoroethylene-hexafluoropropylene copolymers, ethylene-polyethylene tetrafluoride copolymers, ethylene-ethylene trifluorochloride copolymers, tetrafluoroethylene-perfluoroalkylvinyl ether copolymers, amorphous fluorinated resins such as perfluorocyclo polymers, vinylether-fluoroolefin copolymers, vinylester-fluoroolefin copolymers, various fluorinated elastomers and the like. Fluorinated polymers comprising primarily vinylether-fluoroolefin copolymers and vinylester-fluoroolefin copolymers may be particularly advantageous, as they tend to be easy to handle and perhaps even less susceptible to decomposition and degradation.

Silicone-based polymers are also believed to be advantageous when the adhesive strength of the barrier layer 90 is preferably maximized. It is anticipated that a variety of silicone-based polymers would be advantageous in this regard, including: linear silicone resins, acryl-modified silicone resins, various silicone elastomers, and the like. Examples include methyltrichlorosilane, methyltribromosilane, methyltrimethoxysilane, methyltriethoxysilane, methyltriisopropoxysilane, methyltri-t-buthoxysilane; ethyltrichlorosilane, ethyltribromosilane, ethyltrimethoxysilane, ethyltriethoxysilane, ethyltriisopropoxysilane, ethyltri-t-buthoxysilane; n-propyltrichlorosilane, n-propyltribromosilane, n-propyltrimethoxysilane, n-propyltriethoxysilane, n-propyltriisopropoxysilane, n-propyltri-t-buthoxysilane; n-hexyltrichlorosilane, n-hexyltribromosilane, n-hexyltrimethoxysilane, n-hexyltriethoxysilane, n-hexyltriisopropoxysilane, n-hexyltri-t-buthoxysilane; n-decyltrichlorosilane, n-

decyltribromosilane, n-decyltrimethoxysilane, n-decyltriethoxysilane, n-decyltriisopropoxysilane, n-decyltri-t-buthoxysilane; n-octadecyltrichlorosilane, n-octadecyltribromosilane, n-octadecyltrimethoxysilane, n-octadecyltriethoxysilane, n-octadecyltriisopropoxysilane, n-octadecyltri-t-buthoxysilane; phenyltrichlorosilane, phenyltribromosilane, phenyltrimethoxysilane, phenyltriethoxysilane, phenyltriisopropoxysilane, phenyltri-t-buthoxysilane; tetrachlorosilane, tetrabromosilane, tetramethoxysilane, tetraethoxysilane, tetrabuthoxysilane, dimethoxydiethoxysilane; dimethyldichlorosilane, dimethyldibromosilane, dimethyldimethoxysilane, dimethyldiethoxysilane; diphenyldichlorosilane, diphenyldibromosilane, diphenyldimethoxysilane, diphenyldiethoxysilane; phenylmethyldichlorosilane, phenylmethyldibromosilane, phenylmethyldimethoxysilane, phenylmethyldiethoxysilane; trichlorohydrosilane, tribromohydrosilane, trimethoxyhydrosilane, triethoxyhydrosilane, triisopropoxyhydrosilane, tri-t-buthoxyhydrosilane; vinyltrichlorosilane, vinyltribromosilane, vinyltrimethoxysilane, vinyltriethoxysilane, vinyltriisopropoxysilane, vinyltri-t-buthoxysilane; trifluoropropyltrichlorosilane, trifluoropropyltribromosilane, trifluoropropyltrimethoxysilane, trifluoropropyltriethox. silane, trifluoropropyltriisopropoxysilane, trifluoropropyltri-t-buthoxysilane; gamma-glycidoxypropylmethyldimethoxysilane, gamma-glycidoxypropylmethyldiethoxysilane, gamma-glycidoxy-propyltrimethoxysilane, gamma-glycidoxypropyltriethoxysilane, gamma-glycidoxypropyltriisopropoxysilane, gamma-glycidoxy propyltri-t-buthoxysilane; gamma-methacryloxypropylmethyl dimethoxysilane, gamma-methacryloxypropylmethyldiethoxysilane, gamma-methacryloxypropyltrimethoxysilane, gamma-methacryloxy-propyltriethoxysilane, gamma-methacryloxypropyltriisopropoxy silane, gamma-methacryloxypropyltri-t-buthoxysilane; gamma-aminopropylmethyldimethoxysilane;gamma-aminopropylmethyl diethoxysilane, gamma-aminopropyltrimethoxysilane,gamma-aminopropyltriethoxysilane,gamma-a minopropyltriisopropoxy silane, gamma-aminopropyltri-t-buthoxysilane; gamma-mercaptopropylmethyldimethoxysilane, gamma-mercaptopropyl methyldiethoxysilane, gamma-mercaptopropyltrimethoxysilane, gamma-mercaptopropyltriethoxysilane, gamma-mercaptopropyl triisopropoxysilane, gamma-mercaptopropyltri-t-buthoxysilane; .beta.-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, .beta.-(3,4-epoxycyclohexyl) ethyltriethoxysilane; partial hydrolizates of any of the foregoing; and mixtures of any of the foregoing.

In many cases, it will be preferable to form the barrier layer 90 of material that offers minimal permeability to water. Materials displaying this property include, but are not limited to, metals, polymers, ceramics, glasses, composites, and combinations thereof. Of these, polymers (particularly those listed above) are anticipated to be particularly advantageous.

Figure 10 illustrates an embodiment similar to that of Figure 9, but wherein a multiple-pane IG unit has been mounted in a frame. The illustrated glazing assembly generally includes an IG unit, a frame, and glazing compound. This IG unit is of the same basic nature as that shown in Figure 7, except that the exterior coating 420 has not been edge deleted. As with the embodiment of Figure 9, this IG unit is mounted in the frame 50 such that the edge regions of the IG unit are encased by confronting mounting surfaces 55 of the frame 50.

In the present embodiment, at least one of the panes carries an active coating on its outer surface. In Figure 10, the first pane 10 of the IG unit bears the active exterior coating 20. Alternatively, the outer surface 12' of the second pane 10' can be provided with an active coating (not shown). As still another alternative, the outer surfaces of both panes can be provided with coatings. For example, active coatings can be provided on the outer surfaces of both panes, if so desired. Alternatively, an active coating can be provided on the outer surface of one pane, while a coating of another type is provided on the outer surface of the other pane. In such cases, the nature of the coating on the outer surface of the other pane (i.e., the non-active coating) can be varied depending on the properties intended for the mounted IG unit.

In this embodiment, a coated outer surface 12 of the IG unit is retained against a mounting surface 55 of the frame 50. For example, the outer surface 12 of the first pane 10 is retained against the adjacent mounting surface 55 of the frame 50. A bead of glazing compound 70 is disposed between a peripheral region of the coated outer surface 12 and the adjacent mounting surface 55 of the frame 50. This glazing compound 70 is shielded from direct contact with the active coating 420 by a barrier layer 90 provided between the coated outer surface 12 and the glazing compound 70. As in the embodiment of Figure 9, the barrier layer 90 is provided to prevent deterioration of the glazing compound by keeping the glazing compound and the active coating out of direct contact with each other. The barrier layer 90 in this embodiment can be formed of any of the materials described above with reference to Figure 9. Likewise, the application methods described above would be equally useful in the embodiment of Figure 10.

One or both panes of the glazing illustrated in Figure 10 can be provided with an optional interior low-emissivity coating. For example, the first pane 10 of the illustrated IG unit bears an interior low-emissivity coating 40. However, the second pane 10' can be alternatively provided with an interior low-emissivity coating (not shown). As still another alternative, both panes can be provided with interior low-emissivity coatings. Each interior low-emissivity coating 40 is preferably edge deleted to facilitate bonding with the spacer 101. Thus, the inner surface of the first pane 12 preferably has a peripheral region 140 that is substantially free of the low-emissivity coating 40.

The present edge treatments are particularly advantageous in cases where monolithic substrates or IG units are provided with an active exterior coating that would otherwise be placed in direct contact with glazing compound 70 comprising material to which the active coating 20 is degenerative. For example, it may be desirable to employ glazing compound comprising organic material in conjunction with an exterior photocatalytic coating. As noted above, organic materials may be chemically degraded if bonded directly to a photocatalytic coating. Thus, it would be desirable to assure that active coating and organic glazing compound do not contact each other. The present edge treatments can be employed quite advantageously toward this end.

Figure 11 illustrates another embodiment of the invention involving a monolithic glazing. The glazing generally includes a substrate, a frame, and durable glazing compound. The substrate 10 has generally opposed first 12 and second 14 major surfaces. At least one of the major surfaces bears an active coating. The illustrated substrate 10 bears an active coating 420 on its first major surface 12, while the second major surface 12' is uncoated. Alternatively, the second major surface 12' can be provided with an active coating (not shown), and the first major surface 12 can be left uncoated. As still another alternative, both major surfaces of the substrate 10 can be provided with coatings. For example, active coatings can be provided on both major surfaces, if so desired. Alternatively, an active coating can be provided on one major surface, while another type of coating is provided on the other major surface. In such cases, the nature of the coating on the other major surface (i.e., the non-active coating) can be varied depending on the properties intended for the substrate.

In the present embodiment, the coated surface 12 of the substrate 10 is retained against a mounting surface 55 of the frame 50. In Figure 11, the first major surface 12 of the substrate 10 is retained against the adjacent mounting surface 55 of the frame. A bead of

durable glazing compound 170 is disposed between a peripheral region of the coated surface 12 and the adjacent mounting surface 55 of the frame 50. The durable glazing compound 170 is in direct contact with the active coating 420 on the substrate 10. However, this glazing compound 170 is resistant to the self-cleaning mechanism of the active coating 20 (i.e., it is durable to the active coating).

Figure 12 illustrates another embodiment that involves durable glazing compound. The illustrated glazing generally includes an IG unit, a frame, and durable glazing compound. The basic structure and coating options for the IG unit of Figure 12 are generally the same as those discussed above with reference to Figure 10. Thus, while the IG unit of Figure 12 is depicted carrying only one exterior coating 420 and an optional interior low-emissivity coating 40, additional coatings can be provided depending on the properties desired for the IG unit.

In the embodiments of Figures 11 and 12, the glazing compound 170 can be formed of a variety of durable materials. For example, the materials disclosed in the above-referenced '825 patent are anticipated to be useful components of the durable glazing compound 170. As noted above, these materials include silicon compounds (e.g., water glass, colloidal silica, polyorganosiloxanes, etc.), phosphates (e.g., zinc phosphate, aluminum phosphate, etc.), fluorinated polymers, and silicone-based polymers. Further, the materials disclosed in U.S. patents 5,616,532, 5,849,200, and 5,854,169, the entire teachings of each of which are incorporated herein by reference, are anticipated to be useful components of the present durable glazing compound 170.

Fluorinated polymers and silicone-based polymers are expected to be particularly advantageous when it is intended to maximize the adhesion strength of the durable glazing compound 170. Further, fluorinated polymers comprising primarily vinylether-fluoroolefin copolymers and vinylester-fluoroolefin copolymers may be preferred, as they tend to be easy to handle and perhaps even less susceptible to decomposition and degradation. In most cases, it will be preferable to form the durable glazing compound 170 of material that offers minimal permeability to water. Materials displaying this property include, but are not limited to, metals, polymers, ceramics, glasses, composites, and combinations thereof. Of these, polymers (particularly those listed above) are preferred.

While preferred embodiments of the present invention have been described, it should be understood that various changes, adaptations and modifications may be made therein without departing from the spirit of the invention and the scope of the appended claims.